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A COST-EFFECTIVE BEER BREWING PROCESS

The invention concerns an innovative process for brewing beer. The goal of the invention is to disclose a process that reduces considerably the present-day product losses and the resulting serious ecological problems with their associated costs.

Recent publications indicate that the world-wide product losses in beer brewing including processed raw and intermediate materials and final product lie in the region of 20-30%. The main sources of loss occur in the mash production and filtration followed by beer clarification operations after fermentation. Alone in the mashing process losses of up to 20% are caused by incomplete breakdown of the starch and polysaccarides. Up to 10% of the available fermentable sugars from mashing is lost in the mash filtration operation because of inefficient recovery of the fermentable sugars contained in the thick beds of the coarse mashing residues remaining at the end of the filtration operation. Beer losses of the fermented wort of up to 10% are incurred in the average brewery according to the particular type of brewing process, for instance, whether bottom or top fermentation is practiced or whether conditioning substances for clarification after fermentaion are used or not. It is commonly acknowledged that for every litre of beer produced 5-10 litres of biologically highly contaminated effluent are generated.

The Invention

Fig.1 is a flow-sheet of a conventional brewery. The clarification stages 103, 105, 107, 109, 110, 112, 113, 114, 116, 117 causing a large part of the product loss and effluent problem are replaced in the present invention by the stages 202, 204 illustrated in Fig.2 the apparatus of which complies with the genre of filtration equipment disclosed in GB2280857. These are band filters with a filter chamber through which a filter band is intermittently transportable over a support surface that divides the filter chamber into a lower filtrate chamber and an upper turbid liquid chamber, whereby the turbid liquid chamber has a lid-like form and the filter band during the operation when a pressure differential in the filter chamber develops is sealed between the movable dependent edges of the turbid liquid chamber and the filtrate chamber. The advantage of the further developed version of this band filter is that suspensions of finely divided solids can be

filtered fully automatically with the exclusion of air, whereby the residual dissolved products in the thin layers of filtered solids formed are largely recoverable producing a dewatered dischargeable filter cake and a sterile filtrate. With the application of membranous filter bands with particulate cut-off sizes of 0.01-1.0 micron, malt and grain grist for mashing are milled to a mean particle size of 20-100 micron. Such values lead to a much improved yield of fermentable sugars in mashing as well as in washing the spent grist after filtration. According to the invention, the finely divided grist is mashed in a reactor-type of vessel **201**, whereby after heating in stages by means of a heat transfer jacket **213** vacuum is applied by a vacuum generating plant **216** and the agitated contents of the reactor are blown with live steam through a distributor **217**, whereby with comparatively low temperatures and steam consumption undesirable off-taste producing volatiles are removed. from the mash and the precipitation of the hot-break and the breakdown of enzymatic materials as well as sterile conditions are achieved. Subsequently, the agitated contents of the mashing reactor are cooled to precipitate the proteinaceous matter of the cold-break and then filtered by the band filter plant **202.** According to the invention, the finely ground husks and other residual hard materials of the mash are used as filter aid to remove solids and colloids down to 0.01 micron, whereby preferably *membranous* bands with 0.01 micron particle size cut-off are employed. Thedewatered filter cake after desweetening is then discharged.

The cooled, filtered, sterile wort is then transferred to the reactor-like fermentation vessels **203** where, according to a further central aspect of the present invention, in order to maintain the wort both before, during and after fermentation free from turbidity caused by the precipitation of protein-like substances, adsorbents such as silica, resins, molecular sieves, etc are added to the wort before and/or during the fermentation process. The purpose of this is to target and remove the maximum quantity of remaining subsequent haze-forming components still in the wort as well as those metabolically produced by the yeast cells during fermentation and thereby, in effect, achieve a stabilized beer direct from the fermenter. According to the invention, to achieve quality reproducibility and efficient removal of haze-forming substances during fermentation a programmed empirical relationship over the period of the batch-wise fermentation between the temperature, pressure and carbon dioxide evolution in the fermenter by means of controllers **223, 220, 218** is maintained. The yeast cells and adsorbent are held protectively by the agitator **222**

in suspension during fermentation and the subsequent filtration. This, according to the invention, promotes the sterility of the apparatus, the quality and yield of the beer, a smoothly running fermentation as well as a considerable reduction in the required cleaning effort of both the fermenter **203** and the filter plant **204** and therefore the effluent problem. The further advantage of the continuous agitation of the fresh yeast cells is their reduction in this state of the off-taste producing diacetyl remaining after the fermentation. Further, in order to conserve the integrity of the fresh yeast cells and therefore the quality of the filtered beer, the agitated contents of the fermenter after chilling are pressured with compressed gas through the 0.01 micron *membranous* band of the filter plant **204**. In this way the filtered, stabilized beer is directly packed at **207** for consumption. A washed, dewatered yeast cake is discharged at **215**.

The considerably reduced quantity of effluent produced during the equipment cleaning and sterilizing operations with the above described innovative brewing process is, according to the invention, treated with a *membranous* filter plant **211** similar to the process filter plants **202, 204.** Solid adsorbents and ion-exchange materials are used to maintain an acceptable soluble organic and inorganic content in the recycled sterile washing and sterilizing liquids. In this way a closed brewery with respect to effluents is achieved by the process of the invention.